

## CLAIMS

### What is claimed is:

1. A fuel injector testing system, comprising:
  - a sleeve forming a cavity with an inside surface, where the sleeve has at least two interfaces on the inside surface, where the sleeve forms at least one test orifice to the cavity, and where the at least one test orifice is positioned between the at least two interfaces;
  - at least one connector mounted on the sleeve, where the at least one connector forms a passage to the at least one test orifice;
  - a tube interchangeably connected to the at least one test connector; and
  - an air displacement mechanism connected to the tube.
2. The fuel injector test system of Claim 1, further comprising a test plug having at least two O-rings on an outside surface, where the at least two O-rings sealably engage the at least two interfaces when the test plug is inserted in the cavity, and where the test plug and the sleeve form at least one check volume between the at least two O-rings.
3. The fuel injector test system of Claim 1, where the air displacement mechanism adds air to the at least one check volume.
4. The fuel injector test system of Claim 3, where the at least one check volume has a pressure in the range of about 31 inches of Hg (787 Torr) through about 35 inches of Hg (889 Torr).
5. The fuel injector test system of Claim 1, where the air displacement mechanism removes air from the at least one check volume.
6. The fuel injector test system of Claim 5, where the at least one check volume has a pressure in the range of about 25 inches of Hg (635 Torr) through about 29 inches of Hg (737 Torr).

7. The fuel injector test system of Claim 1, where the air displacement mechanism comprises:

- an air passage connected to the tube;
- an air pump connected to the air passage;
- a pressure gauge connected to the air passage; and
- a valve connected to the air passage at a position between the air pump and pressure gauge.

8. A fuel injector testing system for a hydraulically activated electronically controlled unit injection (HEUI) fuel injector, comprising:

- a sleeve forming a cavity with an inside surface, where the inside surface has a top interface, a middle interface, and a bottom interface, where the sleeve forms a first test orifice connected to the cavity, where the first test orifice is positioned between the top and middle interfaces, where the sleeve forms a second test orifice connected to the cavity, and where the second test orifice is positioned between the bottom and middle interfaces,

- where the top, middle, and bottom interfaces sealably engage top, middle, and bottom O-rings on a HEUI fuel injector when the HEUI fuel injector is inserted into the cavity,

- where the sleeve forms a first test volume between the top and middle interfaces when the HEUI fuel injector is inserted into the cavity,

- where the sleeve forms a second test volume between the top and middle interfaces when the HEUI fuel injector is inserted into the cavity,

- where the first and second test volumes extend into HEUI fuel injector;
- and

- a first connector mounted on the sleeve, where the first connector forms a first passage to the first test orifice;

- a second connector mounted on the sleeve, where the second connector forms a second passage to the second test orifice;

- a tube interchangeably connected to at least one of the first and second test connectors; and

- an air displacement mechanism connected to the tube.

9. The fuel injector test system of Claim 8, where the air displacement mechanism adds air to at least one of the first and second test volumes when the HEUI fuel injector is inserted into the cavity.

10. The fuel injector test system of Claim 9, where at least one of the first and second test volumes has a pressure in the range of about 31 inches of Hg (787 Torr) through about 35 inches of Hg (889 Torr).

11. The fuel injector test system of Claim 8, where the air displacement mechanism removes air from at least one of the first and second test volumes when the HEUI fuel injector is inserted into the cavity.

12. The fuel injector test system of Claim 11, where at least one of the first and second check volumes has a pressure in the range of about 25 inches of Hg (635 Torr) through about 29 inches of Hg (737 Torr).

13. The fuel injector test system of Claim 1, further comprising:  
a test plug having an outside surface;  
an upper O-ring connected to the outside surface, where the upper O-ring sealably engages the top interface when the test plug is inserted in the cavity;  
a center O-ring connected to the outside surface, where the center O-ring sealably engages the middle interface when the test plug is inserted in the cavity; and  
a lower O-ring connected to the outside surface, where the lower O-ring sealably engages the bottom interface when the test plug is inserted in the cavity;  
where the test plug and the sleeve form a first check volume between the upper and center O-rings, and  
where the test plug and the sleeve form a second check volume between the lower and center O-rings.

14. The fuel injector test system of Claim 13, where the air displacement mechanism adds air to at least one of the first and second check volumes.

15. The fuel injector test system of Claim 14, where at least one of the first and second check volumes has a pressure in the range of about 31 inches of Hg (787 Torr) through about 35 inches of Hg (889 Torr).

16. The fuel injector test system of Claim 13, where the air displacement mechanism removes air from at least one of the first and second check volumes.

17. The fuel injector test system of Claim 16, where the at least of the first and second check volume has a pressure in the range of about 25 inches of Hg (635 Torr) through about 29 inches of Hg (737 Torr).

18. The fuel injector test system of Claim 8, where the air displacement mechanism comprises:

- an air passage connected to the tube,
- an air pump connected to the air passage
- a pressure gauge connected to the air passage
- a valve connected to the air passage at a position between the air pump and pressure gauge.

19. A method for testing a fuel injector, comprising:  
mechanically isolating at least one test volume of a fuel injector with a sleeve;  
changing the amount of air in the at least one test volume; and  
testing the at least one test volume for air leakage.

20. The method for testing a fuel injector of Claim 19, further comprising sealably engaging at least two O-rings on the fuel injector with at least two interfaces on the sleeve.

21. The method for testing a fuel injector of Claim 19, further comprising:  
adding air to the at least one test volume until the at least one test volume reaches a selected pressure level; and  
after a time period, determining whether the at least one test volume has a pressure less than a tolerance below the selected pressure level.

22. The method for testing a fuel injector of Claim 21,  
where the selected pressure level is in the range of about 31 inches Hg (787 Torr) through about 35 inches Hg (889 Torr);  
where the time period is in the range of about 5 minutes through about 7 minutes; and  
where the tolerance is in the range of about 0 through about 0.5 inches of Hg (11 Torr).

23. The method for testing a fuel injector of Claim 19, further comprising:  
removing air from the at least one test volume until the at least one test volume reaches a selected vacuum level; and  
after a time period, determining whether the at least one test volume has a pressure more than a tolerance above the selected vacuum level

24. The method for testing a fuel injector of Claim 23,  
where the selected vacuum level is in the range of about 25 inches Hg (635 Torr) through about 29 inches Hg (737 Torr),  
where the time period is in the range of about 5 minutes through about 7 minutes, and  
where the tolerance is in the range of about 0 through about 0.5 inches of Hg (11 Torr).

25. The method for testing a fuel injector of Claim 19, further comprising:  
mechanically isolating at least one check volume of a test plug with the sleeve;  
changing the amount of air in the at least one check volume; and  
testing the at least one check volume for air leakage.

26. The method for testing a fuel injector of Claim 25, further comprising sealably engaging at least two O-rings on the test plug with at least two interfaces on the sleeve.

27. The method for testing a fuel injector of Claim 25, further comprising:  
adding air to the at least one check volume until the at least one check volume reaches a selected pressure level; and  
after a time period, determining whether the at least one check volume has a pressure less than a tolerance below the selected pressure level.
28. The method for testing a fuel injector of Claim 27,  
where the selected pressure level is in the range of about 31 inches Hg (787 Torr) through about 35 inches Hg (889 Torr);  
where the time period is in the range of about 5 minutes through about 7 minutes; and  
where the tolerance is in the range of about 0 through about 0.5 inches of Hg (11 Torr).
29. The method for testing a fuel injector of Claim 19, further comprising:  
removing air from the at least one check volume until the at least one check volume reaches a selected vacuum level; and  
after a time period, determining whether the at least one check volume has a pressure less than a tolerance below the selected vacuum level
30. The method for testing a fuel injector of Claim 29,  
where the selected vacuum level is in the range of about 25 inches Hg (635 Torr) through about 29 inches Hg (737 Torr),  
where the time period is in the range of about 5 minutes through about 7 minutes, and  
where the tolerance is in the range of about 0 through about 0.5 inches of Hg (11 Torr).
31. The method for testing a fuel injector of Claim 19, where the fuel injector is a hydraulically activated electronically controlled unit injection (HEUI) fuel injector.